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Transportation Regulations for Lithium, Lithium Ion and Polymer Cells and Batteries

Which organizations and regulations govern the transport of lithium, lithium ion and polymer cells and batteries?

The regulations that govern the transport of primary (non-rechargeable) lithium (metal) and rechargeable lithium ion (including polymer) cells and batteries include the International Civil Aviation Organization (ICAO) Technical Instructions and corresponding International Air Transport Association (IATA) Dangerous Goods Regulations, and the International Maritime Dangerous Goods (IMDG) Code. In addition, lithium and lithium ion cells and batteries are regulated in the U.S. in accordance with Part 49 of the Code of Federal Regulations, (49 CFR Sections 100-185) of the U.S. Hazardous Materials Regulations (HMR). Section 173.185 and the Special Provisions contained in Section 172.102 provide information on the exceptions and packaging for shipping based on details of weights, tests and classifications. The hazardous materials table in Section 172.101 also provides related shipping information. The Office of Hazardous Materials Safety, which is within the U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), is responsible for writing the U.S. regulations that govern the transportation of hazardous materials (also known as dangerous goods) by air, rail, highway and water and drafting the regulations that govern such materials. These regulations are based on the UN Recommendations on the Transport of Dangerous Goods Model Regulations and UN Manual of Tests and Criteria.

What transportation regulations are currently in effect in the U.S.?

Based on the mass of lithium in the anode of a lithium metal or lithium alloy cell (for primary cells and batteries) and equivalent lithium content (for lithium ion cells and batteries), the shipping regulations outlined in the chart below are currently in effect or go into effect on January 1, 2008. However, the U.S. DOT published a lithium battery final rule on August 9, 2007 that provides shippers additional time to comply with certain marking and testing requirements when shipping "small" cells and batteries. See footnotes below. Pages 2 and 3 contain additional requirements on shipping primary lithium (metal) cells and batteries.

Primary Cell / Battery Max. Lithium Content	Lithium Ion & Polymer Cell / Battery Max. Lithium Content	Shipping Classification/Testing	Special Packaging/Markings
1.0 gram / 2.0 grams	1.5 grams / 8.0 grams	Excepted / T1-T8 (1)	Yes (2)
5.0 grams / 25 grams	5.0 grams / 25 grams	Class 9 / T1-T8 (3) (7)	Yes (5)
>5.0 grams / >25 grams	>5.0 grams / >25 grams	Class 9 / T1-T8 (4) (7)	Yes (6)

(1) Starting October 1, 2009, cells and batteries must pass UN T1-T8 Tests. Cells and batteries that pass UN Tests are excepted from regulation.

(2) Starting October 1, 2008, packages containing more than 12 batteries or 24 cells must meet certain packaging, marking, and shipping paper requirements. See pages 7 and 8.

(3) Cells and batteries must pass UN T1-T8 Tests. Starting October 1, 2008 must be shipped as Class 9 hazardous materials *unless transported by motor vehicle or rail car.*

(4) Must pass UN T1-T8 Tests and be shipped as a Class 9 hazardous material.

(5) Requires Class 9 markings, label, specification packaging, and shipping papers *unless transported by motor vehicle or rail car.*

(6) Requires Class 9 markings, label, specification packaging, and shipping papers.

(7) 49 CFR 173.185(a)(1) allows for a cell or battery that was first transported prior to January 1, 2006 and is of a type tested pursuant to the UN Manual of Tests and Criteria, Third Revised Edition, 1999, need not be retested.

New lithium battery regulations issued by U.S. DOT on August 9, 2007.

How is equivalent lithium content calculated for lithium ion cells and batteries?

Equivalent lithium content for lithium ion and lithium polymer cells and batteries in grams on a per cell basis is calculated as 0.3 times the rated capacity in ampere-hours. The equivalent lithium content for a battery or battery pack is the rated capacity in ampere-hours for a single cell multiplied by 0.3 and then multiplied by the number of cells in the battery.

What international transportation regulations currently are in effect?

The international transportation regulations require battery and cell manufacturers or companies that ship equipment packed with or containing these cells and batteries to meet UN testing, marking, packaging, labeling and shipping paper specifications. These regulations are incorporated into the ICAO Technical Instructions, IATA Dangerous Goods Regulations, and IMDG Code.
Based on lithium content (for primary cells and batteries) and equivalent lithium content (for lithium ion cells and batteries), the following international shipping regulations apply:

Primary Cell / Battery Max. Lithium Content	Lithium Ion & Polymer Cell / Battery Max. Equiv. Lithium Content	Shipping Classification/Testing	Special Packaging/Markings
1.0 gram / 2.0 grams	1.5 grams / 8.0 grams	Excepted / T1-T8 (1)	Yes (2)
>1.0 gram / >2.0 grams	>1.5 grams / >8.0 grams	Class 9 / T1-T8 (3)	Yes (4)

(1) Cells and batteries must pass UN T1-T8 Tests. Cells and batteries that pass UN Tests are excepted from regulation. NOTE: The IMDG Code contains a grandfather clause for testing "small" cells and batteries until December 31, 2013.
(2) Packages containing more than 12 batteries or 24 cells must meet certain packaging, marking, and shipping paper requirements. See pages 7 and 8.
(3) Cells and batteries must pass UN T1-T8 Tests and be shipped as Class 9 hazardous materials.
(4) Requires Class 9 markings, label, specification packaging, and shipping papers.

The U.S. DOT prohibits the transport of primary lithium (metal) cells and batteries as cargo by passenger aircraft into, out of, or within the United States. What are the implications on shipments of primary lithium (metal) cells and batteries?

The U.S. DOT prohibits the offering for transportation and transportation of primary lithium (metal) cells and batteries as cargo aboard passenger-carrying aircraft into, out of, or within the United States. However, primary lithium (metal) cells with no more than 1 g of lithium content and batteries with an aggregate lithium content of no more than 2 g THAT ARE PACKED WITH OR INSTALLED IN EQUIPMENT are not subject to this prohibition provided the net weight of the batteries in each package does not exceed 5 kg and the package contains no more than the number of lithium batteries or cells necessary to power the piece of equipment.
The following statement (marking) must be placed on packages containing only primary lithium (metal) cells with no more than 1 g of lithium content and batteries with an aggregate lithium content of no more than 2 g that are excepted from regulation under the U.S. HMR: "PRIMARY LITHIUM BATTERIES – FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT" or "LITHIUM METAL BATTERIES - FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT." The marking must be on a background of contrasting color in letters at 12 mm (0.5 inch) in height on packages having a gross mass of more than 30 kg (66 pounds); **or** at least 6 mm (0.25 inch) on packages having a gross mass of 30 kg (66 pounds) or less. Packages containing primary lithium (metal) cells with more than 1 g of lithium content and batteries with an aggregate lithium content of more than 2 g and shipped by cargo aircraft must contain the "Cargo Aircraft Only" label.

Recommended marking for use on packages containing primary lithium (metal) cells with no more than 1 g of lithium content and batteries with an aggregate lithium content of no more than 2 g that are excepted from regulation under the U.S. HMR:

The U.S. DOT's lithium battery final rule that was published on August 9, 2007 also includes a new Special Provision 189 that provides an exception for "medium size" primary lithium (metal) cells and batteries and rechargeable lithium ion cells and batteries *transported by motor vehicle or rail car*. **Effective October 1, 2008,** Special Provision 189 provides "medium" cells and batteries transported by motor vehicle or rail car an exception from the requirements of the U.S. HMR if they meet all of the following:

(A) For primary lithium cells, the lithium content in each cell, is not more than 5 grams and the aggregate lithium content in each battery is not more than 25 grams;

(B) For lithium ion cells, the equivalent lithium content in each cell is not more than 5 grams and the aggregate equivalent lithium content in each battery, is not more than 25 grams;

(C) The cells and batteries have been tested in accordance with the tests in the UN Manual of Tests and Criteria;

(D) Cells or batteries are separated so as to prevent short circuits and are packed in a strong outer packaging or are contained in equipment;

(E) The outside of each package must be marked "LITHIUM BATTERIES - FORBIDDEN FOR TRANSPORT ABOARD AIRCRAFT AND VESSEL" on a background of contrasting color, in letters:

(1) At least 12 mm (0.5 inch) in height on packages having a gross weight of more than 30 kg (66 pounds); or

(2) At least 6 mm (0.25 inch) on packages having a gross weight of 30 kg (66 pounds) or less, except that smaller font may be used as necessary to fit package dimensions; and

(F) Each package with more than 12 medium batteries or 24 medium cells, except when contained in equipment, must comply with the marking, packaging, and documentation requirements listed on page 6.

Recommended marking for use on packages containing primary lithium (metal) cells with no more than 5 grams of lithium content and primary lithium (metal) batteries with an aggregate lithium content of no more than 25 grams or lithium ion cells with an equivalent lithium content of no more than 5 grams and lithium ion batteries with an aggregate equivalent lithium content of no more than 25 grams *when transported by motor vehicle or rail car:*

LITHIUM BATTERIES – FORBIDDEN FOR TRANSPORT ABOARD AIRCRAFT AND VESSEL

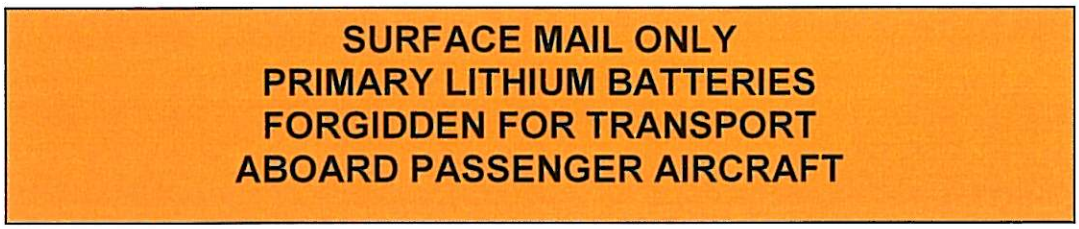
LITHIUM METAL BATTERIES – FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT

What U.S. Postal Service transportation regulations are in effect?

Effective October 5, 2007, the U.S. Postal Service (USPS) revised its standards for mailing lithium and lithium ion batteries. The new standards identify all small consumer-type lithium batteries as mailable when properly packaged and labeled.
Small consumer-type primary (non-rechargeable) lithium cells or batteries (lithium metal or lithium alloy) like those used to power cameras and flashlights are mailable with the following restrictions. Each cell must contain no more than 1.0 gram (g) of lithium content per cell. Each battery must contain no more than 2.0 g aggregate lithium content per battery. Additionally, each cell or battery must meet the requirements of each test in the *UN Manual of Tests and Criteria,* Part III, and subsection 38.3 as referenced in DOT's hazardous materials regulation at 49 CFR 171.7. All primary lithium cells and batteries must be mailed within a firmly sealed package separated and cushioned to prevent short circuit, movement, or damage. Except for batteries installed in equipment, they must be in a strong outer package. All outer packages must have a complete delivery and return address.
Primary lithium cells and batteries are mailable as follows:

(A) Via surface transportation when the cells or batteries (not packed with or installed in equipment) are ''in the originally sealed packaging.'' They are forbidden aboard passenger aircraft. The outside of the package must be marked on the address side ''Surface Mail Only, Primary Lithium Batteries—Forbidden for Transportation Aboard Passenger Aircraft.'' The mail piece must not exceed 5 pounds.

Marking for use on packages containing primary lithium (metal) cells and batteries:



(B) Via surface or air transportation when the cells or batteries are properly packed with or properly installed in the equipment they operate and the mail piece has no more than the number of batteries needed to operate the device. Cells or batteries properly installed in the device they operate must be protected from damage and short circuit, and the device must be equipped with an effective means of preventing accidental activation. The outside of the package must be marked on the address side ''Package Contains Primary Lithium Batteries.'' The mail piece must not exceed 11 pounds.

Marking for use on packages containing primary lithium (metal) cells and batteries packed with or installed in equipment:

Small consumer-type rechargeable lithium-ion cells and batteries like those used to power cell phones and laptop computers are mailable with the following restrictions. Each cell must contain no more than 1.5 g of equivalent lithium content per cell. Each battery must contain no more than 8.0 g aggregate quantity of equivalent lithium content per battery. Additionally, each cell or battery must meet the requirements of each test in the *UN Manual of Tests and Criteria*, Part III, and subsection 38.3 as referenced in the DOT's hazardous materials regulation at 49 CFR 171.7. All secondary lithium-ion cells and batteries must be mailed in a firmly sealed package separated and cushioned to prevent short circuit, movement, or damage. Except for batteries installed in equipment, they must be in a strong outer package. All outer packages must have a complete delivery and return address.

Lithium ion cells and batteries are mailable as follows:

(A) Via surface or air transportation when individual cells or batteries are mailed or when properly packed with or properly installed in the equipment they operate. Cells or batteries properly installed in the device they operate must be protected from damage and short circuit, and the device must be equipped with an effective means of preventing accidental activation. The outside of the package must be marked on the address side "Package Contains Lithium-ion Batteries (no lithium metal)."

(B) The mail piece must not contain more than 3 batteries.

Marking for use on packages containing lithium ion cells and batteries, including cells or batteries packed with or installed in equipment:

Damaged or Recalled Batteries

Damaged or recalled batteries are prohibited from mailing unless approved by the manager, USPS Mailing Standards.

Battery-Powered Devices

Cells or batteries properly installed in equipment must be protected from damage and short circuit and equipment or devices containing cells or batteries must include an effective means of preventing accidental activation.

USPS LITHIUM BATTERY MAILABILITY CHART

Primary lithium batteries (Small non-rechargeable consumer type batteries)	Surface Transportation	Air Transportation	Mail piece Weight Limit	International APO / FPO
Without the equipment they operate (individual batteries)	Mailable	Prohibited	5lb	Prohibited
Packed with equipment but not installed in equipment	Mailable	Mailable	11 lb	Mailable
Contained (properly installed) in equipment	Mailable	Mailable	11 lb	Mailable

Note 1: Each primary cell must not contain more than 1g lithium content
Note 2: Each primary battery must not contain more than 2 g lithium content

Secondary Lithium-Ion Batteries (small rechargeable consumer type batteries)	Surface Transportation	Air Transportation	Mail piece Weight Limit	International APO / FPO
Without the equipment they operate (individual batteries)	Mailable	Mailable	No more than 3 batteries	Mailable
Packed with equipment but not installed in equipment	Mailable	Mailable	No more than 3 Batteries	Mailable
Contained (properly installed) in equipment	Mailable	Mailable	No more than 3 batteries	Mailable

Note 3: Each secondary cell must not contain more than 1.5 g equivalent lithium content
Note 4: Each secondary battery must not contain more than 8 g equivalent lithium content
Note 5: For secondary batteries (lithium ion) there is a limit of 3 batteries per mail piece

What are the UN "T" tests required by the UN regulatory scheme?

The UN Manual of Tests and Criteria, Fourth Revised Edition (2003), contain the UN T1-T8 Tests that are listed below. These tests only have to be performed once for each cell and battery of a given design, and must be completed prior to shipment. Lithium cells or batteries, which differ from a tested type by:

(a) A change of more than 0.1 g or 20% by mass, whichever is greater, to the cathode, to the anode, or to the electrolyte; or

(b) A change that would materially affect the test results shall be considered a new design type and shall be subjected to the required tests. Cells and batteries of identical design only have to be tested one time. (See Battery Assembly Guidelines for UN Testing Information)

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